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SPACE SHUTTLE

AERODYNAMIC DATA REPORT

JOHNSON SPACE CENTER

HOUSTON, TEXAS

DATA MANagement services

SPACE DIVISION CHRYSLER CORPORATION

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AERODYNAMIC RESULTS OF AN ABORT SEPARATION EFFECTS TEST (IA8) CONDUCTED IN THE NASA/ARC 14-FOOT TRANSONIC WIND TUNNEL ON A MODEL (6-OTS) OF THE ROCKWELL INTERNATIONAL LAUNCH CONFIGURATION INTEGRATED VEHICLE

By

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Prepared under NASA Contract Number NAS9-13247

By

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for

Engineering Analysis Division

Johnson Space Center
National Aeronautics and Space Administration
Houston, Texas

WIND TUNNEL TEST SPECIFICS:

Test Number: ARC 14' TWT 711
NASA Series No.: IA8
Test Date: 12 February to 12 March, 1973

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Chrysler Corporation Space Division assumes no responsiblity for the data presented other than display characteristics.

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EFFECTS TEST (IA8) CONDUCTED IN THE NASA/ARC
14-FOOT TRANSONIC WIND TUNNEL ON A MODEL (6-OTS)
OF THE ROCKWELL INTERNATIONAL LAUNCH
CONFIGURATION INTEGRATED VEHICLE

By J. H. Campbell, II, Rockwell International Space Division

ABSTRACT

Experimental aerodynamic investigations were conducted from February 12 through March 12, 1973 in the NASA/ARC 14-Foot Transonic Wind Tunnel on a 6-OTS 0.015-scale model of a Rockwell International Launch Configuration Integrated Vehicle. The Ames dual sting support separation rig was used to obtain "grid-type" data for Tank-Booster (EOHT-BSRM) abort from Orbiter (SSV)

Freestream data were obtained for the Orbiter to provide a baseline for evaluation of proximity effects.

Data were obtained at Mach numbers from 0.32 to 1.1, and Reynolds number per foot varying from 2.1×10^6 to 3.9×10^6.

Data are not presented in this report. Because of balance failure, a very substantial portion of the test was run with a dummy balance in the Tank Boosters configuration.

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NOMENCLATURE

Tunnel Conditions

Symbol	DATAMAN Symbol	Definition
M_∞	MACH	freestream Mach number
R/ℓ	RN/L	freestream Reynolds number per unit length x 10^{-6}
P_{T_∞}	PT	freestream total pressure, psf
P_∞	P	freestream static pressure, psf
q_∞	Q(PSF)	freesteam dynamic pressure, psf
T_{T_∞}	TT	freestream total temperature, °F

Orbiter

Symbol	DATAMAN Symbol	Definition
α	ALPHAO	angle of attack, deg.
β	BETAO	angle of sideslip, deg.
C_N	CNBO	normal-force coefficient
C_A	CAO	axial-force coefficient
C_m	CLMO	pitching-moment coefficient
C_Y	CYO	side-force coefficient
C_n	CYNO	yawing-moment coefficient
C_ℓ	CBLO	rolling-moment coefficient
C_{A_B}	CABO	base axial-force coefficient
C_{A_c}	CACO	cavity axial-force coefficient

C_{A_F}	CAFO	forebody axial-force coefficient
C_{P_5}	CP5	bodyflap pressure coefficient
X_{cp}/L_B	XCP/LO	normal force center of pressure as fraction of reference body length
Y_{cp}/L_B	YCP/LO	side force center of pressure as fraction of reference body length

Tank-Boosters

α	ALPHAT	angle of attack, deg.
β	BETAT	angle of sideslip, deg.
C_N	CNBT	normal-force coefficient
C_A	CAT	axial-force coefficient
C_m	CLMT	pitching-moment coefficient
C_Y	CYT	side-force coefficient
C_n	CYNT	yawing-moment coefficient
C_ℓ	CBLT	rolling-moment coefficient
$C_{A_{B_T}}$	CABT	tank base axial-force coefficient
$C_{A_{B_{B\ell}}}$	CABB1	left-hand booster base axial-force coefficient
$C_{A_{B_{Br}}}$	CABB2	right-ahnd booster base axial-force coefficient
$C_{A_{C_T}}$	CACT	tank cavity axial-force coefficient

NOMENCLATURE (Concluded)

C_{A_F}	CAFT	forebody axial-force coefficient
X_{CP}/L_B	XCP/LT	normal force center of pressure as fraction of reference body length
X_O	X/D	longitudinal distance from tank nose to Orbiter nose, nondimensionalized by tank diameter
Y_O	Y/D	lateral distance from tank nose to Orbiter nose, nondimensionalized by tank diameter
Z_O	Z/D	vertical distance from tank nose to Orbiter nose, nondimensionalized by tank diameter

Notes:

1. See Data Reduction for mathematical expressions for the various coefficients.
2. See Figure 1-b for clarification of X/D, Y/D, and Z/D.

CONFIGURATIONS INVESTIGATED

Orbiter

$O_6 = B_9\ C_3\ D_6\ E_{21}\ F_2\ K_3\ M_2\ V_2\ W_{90}$, where

<u>Component</u>

B_9	Fuselage body per NR lines drawing VL70-000003A with nose radius increased to 50 inches per VL70-000089A to <u>approximate</u> Revision 1 baseline conf. per VL70-000089A (model drwg. SS-A00013).
C_3	Canopy per NR lines drawing VL70-000032 (model drwg. SS-A00013).
D_6	Manipulator arm housing per NR lines drawing VL70-000044 (model drwg. SS-A00013).
E_{21}	Elevons to mate with W_{90} wing to approximate Revision 1 baseline conf. per VL70-000089A (model drwg. SS-A00013).
F_2	Body flap per NR lines drawing VL70-00012 (model drwg. SS-A00013).
K_3	Coolant inlet pod per NR lines drawing VL70-000037A (model drwg. SS-A00013).
M_2	Orbital Maneuvering Systems per NR lines drawing VL-70-000034 (model drwg. SS-A00013).
V_2	Vertical tail per NR lines drawing VL70-007005A (model drwg, SS-A00014
W_{90}	Wing per NR lines drawing VL70-006001A modified per VL70-000089A to approximate baseline double-delta (model drwg. SS-A00013).

ET/BSRM's - T_7S_3

S_3	BSRM's (left and right) per NR lines drawing VL72-000061 (model drwg. SS-A00064).
T_7	EOHT per NR lines drawing VL72-000061 (model drwg. SS-A00064).

TEST FACILITY DESCRIPTION

The Ames 14-Foot Transonic Wind Tunnel was created by extensive modification of the former Ames 16-Foot High Speed Wind Tunnel. It has an adjustable, flexible-wall nozzle and the test section is slotted on all four sides to permit transonic testing. The air circuit is closed except for the air exchanger, in a low-speed section of the circuit, which is controlled to maintain the air temperature within suitable limits.

The air is driven by a three-stage, axial-flow compressor powered by three electric motors mounted in tandem outside the wind tunnel. The drive system is rated 110,000 horsepower continuously or 132,000 horsepower for one hour. The speed of the motors is continuously variable over the operating range.

Performance:	
Mach number	0.6 to 1.2, continuously variable
Pressure, stagnation, atm	1.0
Reynolds number, per ft	2.8×10^6 to 4.2×10^6
Temperature, stagnation	Controllable over limited range by throttling the air exchanger. Generally about 640° R to avoid condensation of moisture in the test section
Dimensions:	
Test section height, ft	13.50
Test section width, ft	13.71 at upstream end 13.92 at downstream end
Test section length, ft	33.75

DATA REDUCTION

Orbiter

The six body-axis force and moment coefficients were computed for the Orbiter. Balance axial force was adjusted as follows:

$$AF_{0_{adj}} = AF_0 + (P_{c0} - P_{b0})\, A_{c0} \text{ where,}$$

$A_{b(i)}$ - local base area associated with $P_{b(i)}$

A_{c_0} - balance/sting cavity area

AF_0 - unadjusted balance axial force

P_{b_0} - area-weighted base pressure, $\sum_{i=1}^{4} P_{b(i)}A_{b(i)} / \sum_{i=1}^{4} A_{b(i)}$

P_{c_0} - balance/sting cavity pressure

$P_{b(i)}$ - local base pressure

In addition, the following pressure coefficients were computed:

Base axial-force coefficient

$$C_{A_{B_0}} = \frac{(P_{b_0} - P_\infty)\,(A_{b_0} + A_{c_0})}{q_\infty S_0} \qquad \text{where}$$

A_{b_0} - total base area (excluding cavity), $\sum_{i=1}^{4} A_{b(i)}$

P_∞ - freestream static pressure

q_∞ - freestream dynamic pressure

S_0 - wing reference area

Cavity axial-force coefficient:

$$C_{A_{C_0}} = \frac{(P_{c_0} - P_{b_0})A_{c_0}}{q_\infty S_0}$$

Forebody axial-force coefficient:

$C_{A_{F_0}}$ = CAO + CABO, where

C_{A_0} = is the axial-force coefficient based on $AF_{0_{adj}}$

Bodyflap pressure coefficient:

$$C_{P_5} = \frac{P_{b(5)} - P_\infty}{q_\infty}, \text{ where}$$

$P_{b(5)}$ was located on upper surface of bodyflap

Normal force center of pressure:

$$X_{CP}/L_0 = \frac{X_{cg_0}}{L_{B_0}} - \frac{C_{m_0}(\bar{c}_{w_0})}{C_{N_0}(L_{B_0})}, \text{ where}$$

C_{m_0} - pitching-moment coefficient

C_{N_0} - normal-force coefficient

$\bar{c}_{w_0}$ - reference MAC

L_{B_0} - reference body length

X_{cg_0} - longitudinal distance, nose to moment reference center

Side force center of pressure:

$$Y_{CP}/L_0 = \frac{X_{cg_0}}{L_{B_0}} - \frac{C_{n_0}(b_{w_0})}{C_{Y_0}(L_{B_0})}$$

b_{w_0} - reference wing span

C_{n_0} - yawing-moment coefficient

C_{Y_0} - side-force coefficient

Tank-Boosters

The six body-axis force and moment coefficients were computed for the tank boosters. Balance axial force was adjusted as follows:

$AF_{T_{adj}} = AF_T + (P_{c_T} - P_{b_T})A_{c_T}$, where

A_{c_T} - balance/sting cavity area

AF_T - unadjusted balance axial force

P_{b_T} - tank base pressure

P_{c_T} - tank balance/sting cavity area

In addition, the following pressure force coefficients were computed:

Base axial-force coefficient:

a) Tank $$C_{A_{B_T}} = \frac{(P_{b_T} - P_\infty)\,(A_{b_T} + A_{c_T})}{q_\infty S_T}, \text{ where}$$

A_{b_T} - tank base area, excluding cavity

P_∞ - freestream static pressure

S_T - tank-boosters reference area

b) Booster (left-hand):

$$C_{A_{B_{B\ell}}} = \frac{(P_{b\ell} - P_\infty)A_{b\ell}}{q_\infty S_T}, \text{ where}$$

$A_{b\ell}$ - left-hand Booster base area

$P_{b\ell}$ - left-hand Booster base pressure

c) Booster (right-hand):

$$C_{A_{B_{Br}}} = \frac{(P_{b_r} - P_\infty)A_{b_r}}{q_\infty S_T}, \text{ where}$$

A_{b_r} - right-hand Booster base area

P_{b_r} - right-hand Booster base pressure

Cavity axial-force coefficient:

$$C_{A_{c_T}} = (P_{c_T} - P_{b_T})A_{c_T}/q_\infty S_T$$

Forebody axial-force coefficient:

$$C_{A_{F_T}} = C_{A_T} + C_{A_{B_T}} + C_{A_{B_{B\ell}}} + C_{A_{B_{Br}}}$$, where

C_{A_T} - unadjusted axial-force coefficient

Normal force center of pressure:

$$X_{cp}/L_T = \frac{X_{cg_T}}{L_{B_T}} - \frac{C_{m_T}(\bar{c}_{w_T})}{C_{N_T}(L_{B_T})}, \text{ where}$$

C_{m_T} - pitching-moment coefficient

C_{N_T} - normal-force coefficient

$\bar{c}_{w_T}$ - reference MAC

L_{B_T} - reference body length

X_{cg_T} - longitudinal distance, tank nose to moment reference center

Displacements, tank nose to Orbiter nose:
(reference axis system attached to tank)

$$X/D = (X_o + \Delta X)/D$$

$$Y/D = (Y_o + \Delta Y)/D$$

$$Z/D = (Z_o + \Delta Z)/D, \text{ where}$$

X_0, Y_0, Z_0 - displacements for mated configuration

ΔX, ΔY, ΔZ - displacements from mated position

D - tank diameter

Data Reduction Constants

<u>Orbiter</u>

Constant	Definition	Value
A_{b_0}	base area (excluding cavity)	0.0629 ft^2
$A_{b(1)}$	local base area associated with $P_{b(1)}$	0.0241 ft^2
$A_{b(2)}$	local base area associated with $P_{b(2)}$	0.0038 ft^2
$A_{b(3)}$	local base area associated with $P_{b(3)}$	0.0278 ft^2
$A_{b(4)}$	local base area associated with $P_{b(4)}$	0.0072 ft^2
A_{c_0}	sting/balance cavity area	0.02182 ft^2
b_{w_0}	reference wing span	1.1574 ft
$\bar{c}_{w_0}$	reference MAC	0.59575 ft
L_{B_0}	reference body length	1.66042 ft
S_0	reference wing area	0.6042 ft^2
X_{cg_0}	longitudinal distance from Orbiter nose to moment reference center	1.0959 ft
X_o	longitudinal distance, tank nose to Orbiter nose for mated configuration	-11.295 in

Y_o	lateral distance, tank nose to Orbiter nose for mated configuration	0.000 in
Z_o	vertical distance, tank nose to Orbiter nose for mated configuration	-4.2735 in

Tank-Boosters

Constant	Definition	Value
A_{b_T}	tank base area	0.08757 ft^2
A_{b_ℓ}	left-hand Booster base area	0.06585 ft^2
A_{b_r}	right-hand Booster base area	0.06585 ft^2
A_{c_T}	tank balance/sting cavity area	0.04125 ft^2
b_{w_T}	reference wing span (Orbiter body length)	1.66042 ft
$\bar{c}_{w_T}$	reference MAC (Orbiter body length)	1.66042 ft
D	tank reference diameter	4.86 in
L_{B_T}	reference body length	2.855 ft
S_T	reference wing area (Orbiter wing area)	0.6042 ft^2
X_{cg_T}	longitudinal distance from tank nose to moment reference center	1.2331 ft

TABLE 1.

TEST : IA8			DATE :2/12-3/12/73
	TEST CONDITIONS		
MACH NUMBER	REYNOLDS NUMBER (per foot)	DYNAMIC PRESSURE (pounds/sq. inch)	STAGNATION TEMPERATURE (degrees Fahrenheit)
0.32	$\approx 2.1 \times 10^6$	0.95	68-97
0.60	$\approx 3.3 \times 10^6$	2.8	87-104
0.75	$\approx 3.7 \times 10^6$	4.0	96-111
0.90	$\approx 3.9 \times 10^6$	4.9	122-139
1.10	$\approx 3.7 \times 10^6$	5.8	154-182

BALANCE UTILIZED: NASA/ARC Task 1.5-inch MKII C and MKXII A

	CAPACITY:	ACCURACY:	COEFFICIENT TOLERANCE:*
NF	1000 1000 lb.	≤ 0.005 capacity	accuracy/q_∞
SF	500 500 lb.	≤ 0.005 capacity	accuracy/q_∞
AF	100 300 lb.	≤ 0.005 capacity	accuracy/q_∞
PM	- -	≤ 0.005 capacity	accuracy/q_∞
RM	800 800 in-lb.	≤ 0.005 capacity	accuracy/q_∞
YM	- -	≤ 0.005 capacity	accuracy/q_∞

COMMENTS: * Very small inaccuracy in reference dimensions and q_∞.

TABLE 2. - ORBITER FREESTREAM

TEST : IA8

DATA SET/RUN NUMBER COLLATION SUMMARY

DATE : 2/12/73 - 3/12/73

DATA SET IDENTIFIER	CONFIGURATION	SCHD. α	SCHD. β	PARAMETERS/VALUES δe	NO. OF RUNS	0.32	0.60	0.75	0.90	1.10
RBK 001	Orbiter (O_6) *	B	0	0		-	1	9	5	-
RBK 002	Orbiter (O_6)	B	0	0		22	-	27	26	20
RBK 003	Orbiter (O_6)	B	0	15		-	16	13	14	15
RBK 004	Orbiter (O_6) *	B	0	15		-	17	-	-	-
RBK 005	Orbiter (O_6)	B	0	-10		-	31	28	29	30
RBK 006	Orbiter (O_6) *	0	C	0		-	2	10	6	-
RBK 007	Orbiter (O_6)	0	C	0		23	-	-	-	21
RBK 008	Orbiter (O_6) *	15	C	0		-	3	11	7	-
RBK 009	Orbiter (O_6)	15	C	0		18	-	-	-	24
RBK 010	Orbiter (O_6) *	30	C	0		-	4	12	8	-
RBK 011	Orbiter (O_6)	30	C	0		19	-	-	-	25

MACH NUMBERS (OR ALTERNATE INDEPENDENT VARIABLE)

TEST RUN NUMBERS

1 7 13 19 25 31 37 43 49 55 61 67 75 76

CN B CA CA CY CYN CBL CAB CAC CAF CP5

COEFFICENTS IDVAR (1) IDVAR (2) NDV

α OR β SCHEDULES

α) B= -10, -6, -4, -2, 0, 2, 4, 6, 8, 10, 15, 20, 25, 30, 0

β) C= -6, -4, -2, -1, 0, 1, 2, 4, 6, 0

*The secondary sting support of the separation rig (on which the Orbiter was mounted) was in it's most aft position. For all data sets w/o *, it is in most forward position.

TABLE 2. - TANK-BOOSTERS SEPARATION FROM ORBITER (Concluded)

TEST: IA8

DATA SET/RUN NUMBER COLLATION SUMMARY

DATE: 2/12/73 - 3/12/73

DATA SET IDENTIFIER	CONFIGURATION	SCHD. α	SCHD. β	PARAMETERS/VALUES δe	M_∞	X	Y	NO. OF RUNS	Z -0.88	-1.19	-1.50	-1.81	-1.98
RBK 101	O_6, S_3T_7	A	0	0	0.75	-232	0		32	33	34	35	38
RBK 102	O_6, S_3T_7	A	4	0	0.75	-232	0		42	-	-	-	-
RBK 103	O_6, S_3T_7	A	0	0	0.75	-232	1.03		49	-	48	-	41
RBK 104	O_6, S_3T_7	A	4	0	0.75	-232	1.03		-	-	47	-	-
RBK 105	O_6, S_3T_7	A	4	0	0.75	-232	-1.03		43	-	-	-	-
RBK 106	O_6, S_3T_7	A	0	0	0.75	-354	0		45	50	53	54	-
RBK 107	O_6, S_3T_7	A	4	0	0.75	-354	0		46	-	-	-	-
RBK 108	O_6, S_3T_7	A	4	0	0.75	-354	-1.03		44	-	-	-	-
RBK 109	O_6, S_3T_7	A	0	0	1.1	-232	0		36	37	39	40	51
RBK 110	O_6, S_3T_7	A	4	0	1.1	-232	0		52	-	-	-	-

TEST RUN NUMBERS

1 CNB 7 CLM 13 CA 19 CY 25 CYN 31 CBL 37 43 49 55 61 67 75 76

COEFFICENTS IDVAR (1) IDVAR (2) NDV

α OR β SCHEDULES: α) A = -10, -6, -4, -2, 0, 2, 4, 6, 8, 10, 15, 20, 0

NOTES: 1) X, Y and Z have all been non-dimensionalized by dividing by tank dia.

2) No S_3T_7 data after run 41. S_3T_7 mounted on dummy balance, runs 42-54.

3) α and β are for Orbiter, tank and boosters. Boosters rigidly attached to tank.

TABLE 3. - MODEL COMPONENT DESCRIPTIONS

MODEL COMPONENT: B-9

GENERAL DESCRIPTION: Orbiter fuselage per NR lines drawing VL70-00003A with nose radius increased to 50 inches per VL70-000089A to approximate Revision 1 baseline conf. per VL70-000089A.

Scale model = 0.015

DRAWING NUMBER: SS-A00013)

DIMENSIONS:

	FULL-SCALE	MODEL SCALE
Length	1322.3	19.925
Max. Width	222.67	3.340
Max. Depth	239.33	
Fineness Ratio	5.527	5.527
Area ~ ft^2		
Max. Cross-Sectional	315.072	0.071
Planform		
Wetted		
Base		

TABLE 3. (Continued)

MODEL COMPONENT: CANOPY C3

GENERAL DESCRIPTION: Canopy Used With Fuselage B_2 per NR Lines VL70-000032

SCALE MODEL = 0.015

DRAWING NUMBER: SS-A00013

DIMENSIONS:	FULL-SCALE	MODEL SCALE
Sta. Fwd. Bulkhead - in.	398.00	5.970
Sta. Trailing Edge - in.	500.00	7.500
Intersection Fus. ML - in.	398.00	5.970
Fineness Ratio		
Area		
Max. Cross-Sectional		
Planform		
Wetted		
Base		

Windshield consists of six (6) panels.

Pilot's eye is at the following points:

Fus. Sta. - in.	460.00	6.900
BP - in.	22.00	0.330
WP - in.	496.00	7.440

View Angles Available:

Deg. Upward	10.0°	10.0°
Deg. Downward	18.0°	18.0°
Deg. Right	14.0°	14.0°
Deg. Left	14.0°	14.0°

MODEL COMPONENT: BODY - MANIPULATOR ARM HOUSING - D6
PRR BASELINE

GENERAL DESCRIPTION: Manipulator Arm Housing Used with Canopy C3 per NR Lines VL70-000044 & VL70-000033

STA 477.7 to STA 1307.0

SCALE MODEL = 0.015

DRAWING NUMBER: SS-A00013

DIMENSIONS:

	FULL-SCALE	MODEL SCALE
Length ~ in.	829.22	12.438
Max. Width ~ in.	51.60	0.774
Max. Depth ~ in.	22.40	0.336
Fineness Ratio	---	---
Area		
Max. Cross-Sectional	---	---
Planform	---	---
Wetted	---	---
Base	---	---

TABLE 3. (Continued)

MODEL COMPONENT: ELEVON - E21 (Data for Sides 1 of 2)

GENERAL DESCRIPTION: Full span variable chord Elevon used with Wing W90 per NR Lines VL720-000089A)

SCALE MODEL = 0.015

DRAWING NUMBER: SS-A00003

DIMENSIONS:	FULL-SCALE	MODEL SCALE
Area	205.434	0.046
Span (equivalent)	353.341	5.300
Inb'd equivalent chord	114.78	1.722
Outb'd equivalent chord	55.0	0.825
Ratio movable surface chord/ total surface chord		
At Inb'd equiv. chord	0.212	0.192
At Outb'd equiv. chord	0.398	0.398
Sweep Back Angles, degrees		
Leading Edge	0.0	0.0
Tailing Edge	-10.02	-10.02
Hingeline	0.0	0.0
Area Moment (Normal to hinge line)	1540.73	0.0052

PRODUCT OF AREA & MEAN CHORD

Hinge Line at F.S. Sta. 1387.0

TABLE 3. (Continued)

MODEL COMPONENT: BODY - Flap - F2

GENERAL DESCRIPTION: Flap located on lower aft portion of fuselage B2 and extending aft of fuselage trailing edge per NR lines VL70-00012.

MODEL SCALE = 0.015

DRAWING NUMBER: SS-A00013

DIMENSIONS:	FULL-SCALE	MODEL SCALE
Length, in.	83.33	1.250
Fus. Sta. L.E., in.	1528.33	22.925
Fus. Sta. T.E., in.	1611.67	24.175
Width (= Span), in.	229.33	3.440
Area, ft^2		
Max. Cross-Sectional	---	---
Planform	132.72	0.02986
Wetted	---	---
Base	---	---

TABLE 3. (Continued)

MODEL COMPONENT: BODY - COOLANT INLET - K3
PRR Baseline

GENERAL DESCRIPTION: Basic Cooling Inlet for the NR-SSV Orbiter Configuration at the base & leading edge of vertical (V2) per NR lines VL70-000037A

SCALE MODEL = 0.015

DRAWING NUMBER: SS-A00013

DIMENSIONS:	FULL-SCALE	MODEL SCALE
Length	175.2	2.628
Max. Width (dia.)	38.00	0.570
Max. Depth		
Fineness Ratio		
Area		
Max. Cross-Sectional ~ ft^2	7.876	0.002
Planform		
Wetted		
Base		

Located at fuselage Sta. 1309.2 to 1484.4 INFS

BP = 0.00

WP = 539.00 INFS

TABLE 3. (Continued)

MODEL COMPONENT: ORBITAL MANEUVERING SYSTEM - M2
PRR Baseline

GENERAL DESCRIPTION: Orbital Maneuvering System located on Fuselage B2 - per Lines VL70-000034 centerline located at WP = 450.00 INFS.

SCALE MODEL = 0.015

DRAWING NUMBER: SS-A00013

DIMENSIONS:	FULL-SCALE	MODEL SCALE
Length ~ in.	367.00	5.505
Max. Width ~ in.	116.00	1.740
Max. Depth ~ in.	120.00	1.800
Fineness Ratio	---	---
Area		
Max. Cross-Sectional	---	---
Planform	---	---
Wetted	---	---
Base	---	---

TABLE 3. (Continued)

MODEL COMPONENT: VERTICAL TAIL - V2

GENERAL DESCRIPTION: Centerline vertical tail used on fuselage B2.

Double wedge airfoil with rudder and/or speed brake deflection per NR lines VL70-007005A.

MODEL SCALE = 0.015

DRAWING NUMBER: SS-A00014-54, -55

DIMENSIONS:

	FULL-SCALE	MODEL SCALE
TOTAL DATA		
Area, ft^2	415.25	0.09343
*Void (included above)	1.29	0.00029
Blanketed (included above)	19.93	0.00448
Span (equivalent), in.	302.23	4.533
Aspect Ratio	1.605	1.605
Rate of Taper	0.504	0.504
Taper Ratio	0.424	0.424
Dihedral Angle, degrees	---	---
Incidence Angle, degrees	---	---
Aerodynamic Twist, degrees	---	---
Toe-In Angle, degrees	0.000	0.000
Cant Angle, degrees	0.000	0.000
Sweep Back Angles, degrees		
Leading Edge	45.000	45.000
Trailing Edge	26.361	26.361
0.25 Element Line	41.150	41.150
Chords: in.		
Root (W.P. 520.00)	264.58	3.969
Tip, (equivalent) (W.P. 822.23)	112.12	1.682
MAC (W.P. 650.73)	198.63	2.980
Fus. Sta. of .25 MAC	1473.39	22.101
W.P. of .25 MAC	650.73	9.761
B.L. of .25 MAC	0.00	0.00
Airfoil Section		
Root	5° half-angle double wedge with rounded leading edge = 1.6% local chord.	
Tip		
EXPOSED DATA		
Area		
Span, (equivalent)		
Aspect Ratio		
Taper Ratio		
Chords		
Root		
Tip		
MAC		
Fus. Sta. of .25 MAC		
W.P. of .25 MAC		
B.L. of .25 MAC		

* This area is the void area located at the lower aft portion of the surface

TABLE 3. (Continued)

MODEL COMPONENT: Wing W-90

GENERAL DESCRIPTION: Modified W-6 Wing to comply with New Double Delta Configuration per NR lines drawing VL70-000089A.

SCALE MODEL = 0.015

DRAWING NUMBER: SS-A00003

DIMENSIONS:	FULL-SCALE	MODEL SCALE
TOTAL DATA		
Area ~ ft (W.R.P.)		
Planform	2685.51	0.604
Wetted		
Span (equivalent) ~ ft	77.16	1.157
Aspect Ratio	2.217	2.217
Rate of Taper	0.208	0.208
Taper Ratio	1.179	1.179
Diehedral Angle, degrees	3.500	3.500
Incidence Angle, degrees	3.000	3.000
Aerodynamic Twist, degrees	--	--
Toe-In Angle	--	--
Cant Angle	--	--
Sweep Back Angles, degrees		
Leading Edge	44.894	44.894
Trailing Edge	-10.329	-10.329
0.25 Element Line	35.056	35.056
Chords:		
Root (Wing Sta. 0.0)	690.19	10.353
Tip, (equivalent)	143.48	2.152
MAC	476.59	7.149
Fus. Sta. of .25 MAC	1136.54	17.048
W.P. of .25 MAC	287.57	4.134
B.L. of .25 MAC	180.90	2.713
Airfoil Section		
Root	--	--
Tip	--	--
EXPOSED DATA		
Area ~ ft^2	1743.92	0.392
Span, (equivalent) ~ ft	59.16	0.887
Aspect Ratio	2.007	2.007
Taper Ratio	0.255	0.255
Chords		
Root	562.63	8.440
Tip	143.48	2.152
MAC	394.53	5.918
Fus. Sta. of .25 MAC	1185.55	17.783
W.P. of .25 MAC	289.26	4.339
B.L. of .25 MAC	250.40	3.756

DATA FOR (1) SIDE

Leading Edge Cuff		
Plan Form Area ~ ft^2 (BP - 108.0)	108.00	0.243
Leading Edge Intersects Fus. ML. @ Sta.	595.0	8.925
Leading Edge Intersects Wing at Sta.	1035.0	15.525

TABLE 3. (Continued)

MODEL COMPONENT: BSRM (Booster Solid Rocket Motor) - S3

GENERAL DESCRIPTION: Body of Revolution (data for one of two sides) per NR Lines VL72-000061.

SCALE MODEL = 0.015

DRAWING NUMBER: SS-A00064

DIMENSIONS:	FULL-SCALE	MODEL SCALE
Length (excluding nozzle ext. beyond shroud)	1722.0	25.83
Max. Width (dia.) in.	232.0	3.48
Max. Depth		
Fineness Ratio	7.4224	7.4224
Area ~ ft^2		
Max. Cross-Sectional	293.416	0.066
Planform		
Wetted		
Base		

X_o (Orbiter) = Sta. 191.0 (BSRM)

B.P. 0.0 (Orbiter) = 243.0 in. (BSRM)

W.P. 400 (Orbiter) = 344.4 in. (BSRM)

BSRM -- Continued

a) Tip of nose cone has a 13 infs radius with center at $x_s = 213.0$

b) The semivertex angle of the nose cone is 18°45'.

STA 213 to 384.0 infs

c) The nose cone reaches its maximum diameter of 142.0 infs at $x_s = 384.0$

d) The cylindrical body of the booster maintains a constant diameter of 142.0 infs from $x_s = 384.0$ to $x_s = 1763.0$

e) The aft skirt of the booster is a truncated cone with a minimum diameter of 142.0 infs at $x_s = 1763.0$ and a maximum diameter of 232.0 infs at $x_s = 1900.0$. The aft skirt is in the null position.

f) Maximum cross-sectional area $= \frac{(\pi)(232.0)^2}{4}$

$$= 293.416 \text{ ft}^2$$

g) $\frac{L}{D} = \frac{1722.0}{232.0} = 7.4224$

X_o (Orbiter) = Sta 191.0 (BSRM)

BP 0.0 (Orbiter) = 243.0 in. (BSRM)

WP 400 (Orbiter) = 344.4 in. (BSRM)

TABLE 3. (Continued)

MODEL COMPONENT: EOHT (External Oxygen-Hydrogen Tank) - T_7

GENERAL DESCRIPTION: Body of Revolution per NR Lines VL72-000061

SCALE MODEL = 0.015

DRAWING NUMBER: SS-A00064

DIMENSIONS:

	FULL-SCALE	MODEL SCALE
Length	1973.0	29.595
Max. Width (dia.) ~in.	324.0	4.860
Max. Depth		
Fineness Ratio	6.0895	6.0895
Area ~ ft^2		
Max. Cross-Sectional	572.265	0.1288
Planform		
Wetted		
Base		

X_o (Orbiter) = Sta 753 ET

BP (Orbiter) 0.0 = 0.0 ET

WP 400 (Orbiter) = 344.4 in. ET

EOHT -- Continued

a) Nose radius = 20.5 infs, from Sta. 200.0 to 220.5

b) Retro package, Sta. 220.5 to 324.0 infs

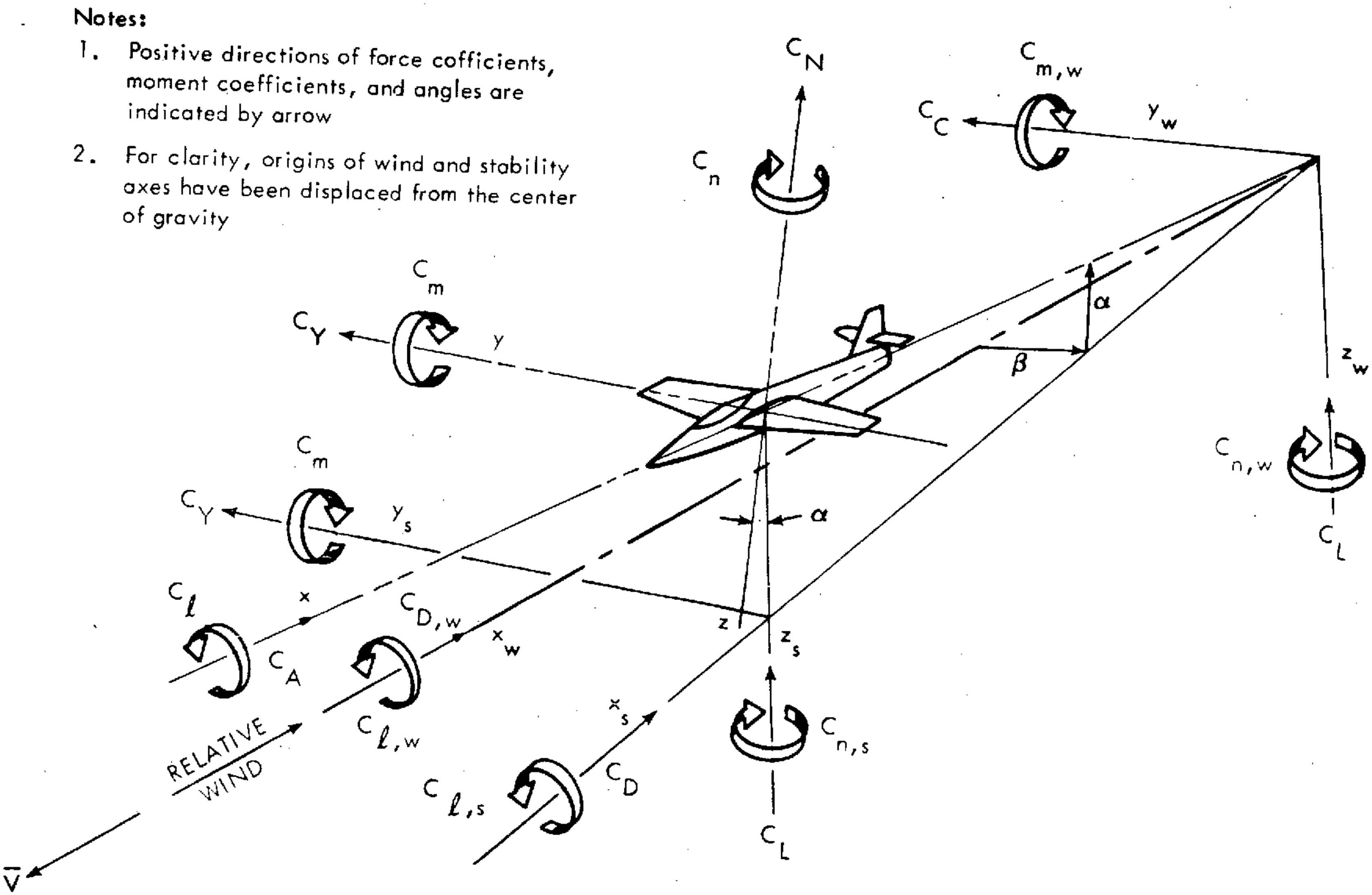
c) Ogive radius = 605.0 infs, from Sta. 324.0 to 711.0

d) Max. dia. = 324.0 infs, from Sta. 1085.5 to 2407.6

e) 3/4 ellipse to form base. Minor diameter = 244.0 infs; major dia. = 324.0 infs

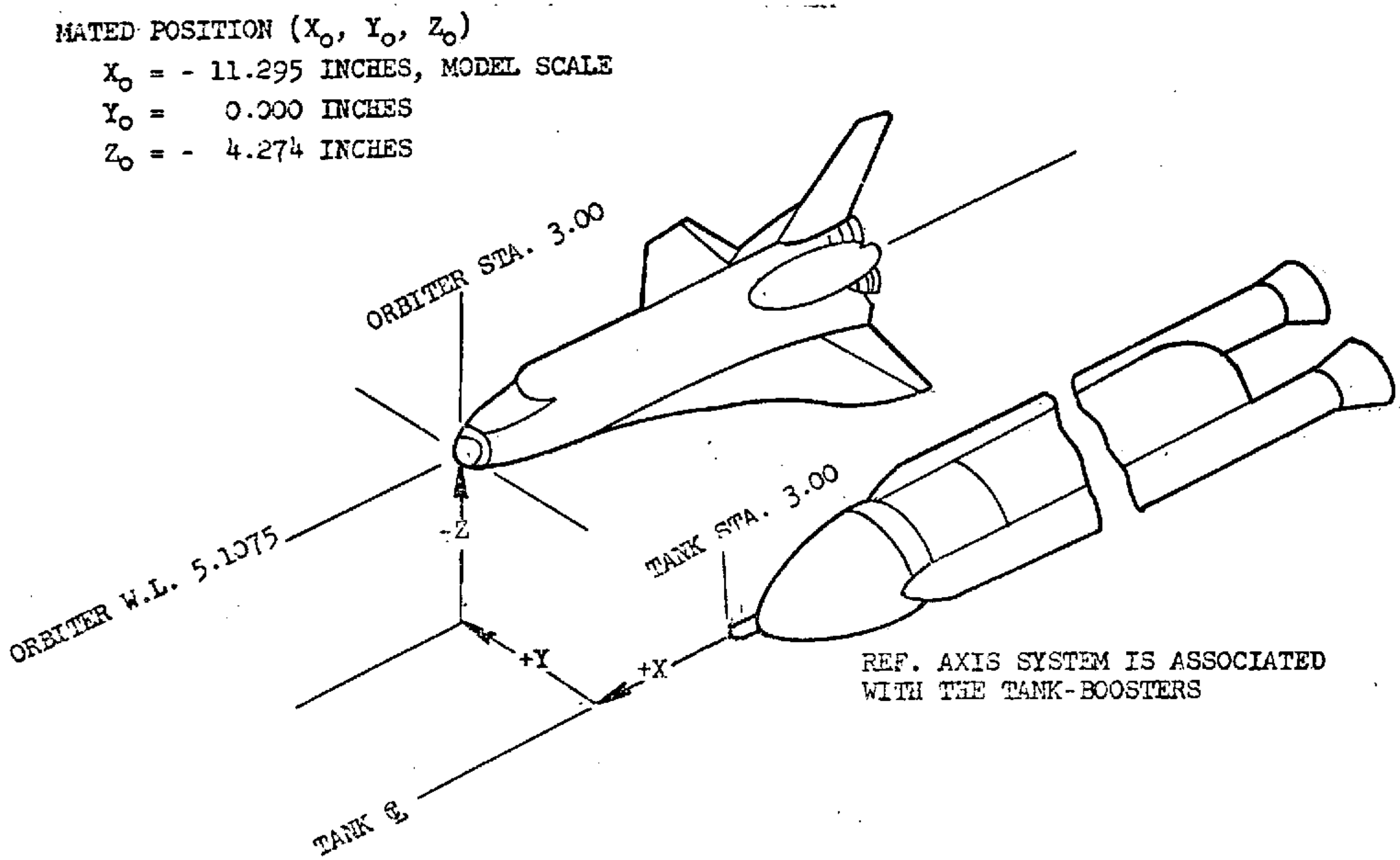
f) Aft base located at Sta. 2173.0

g) L/D = (2173 - 200)/324.0 = 6.0895



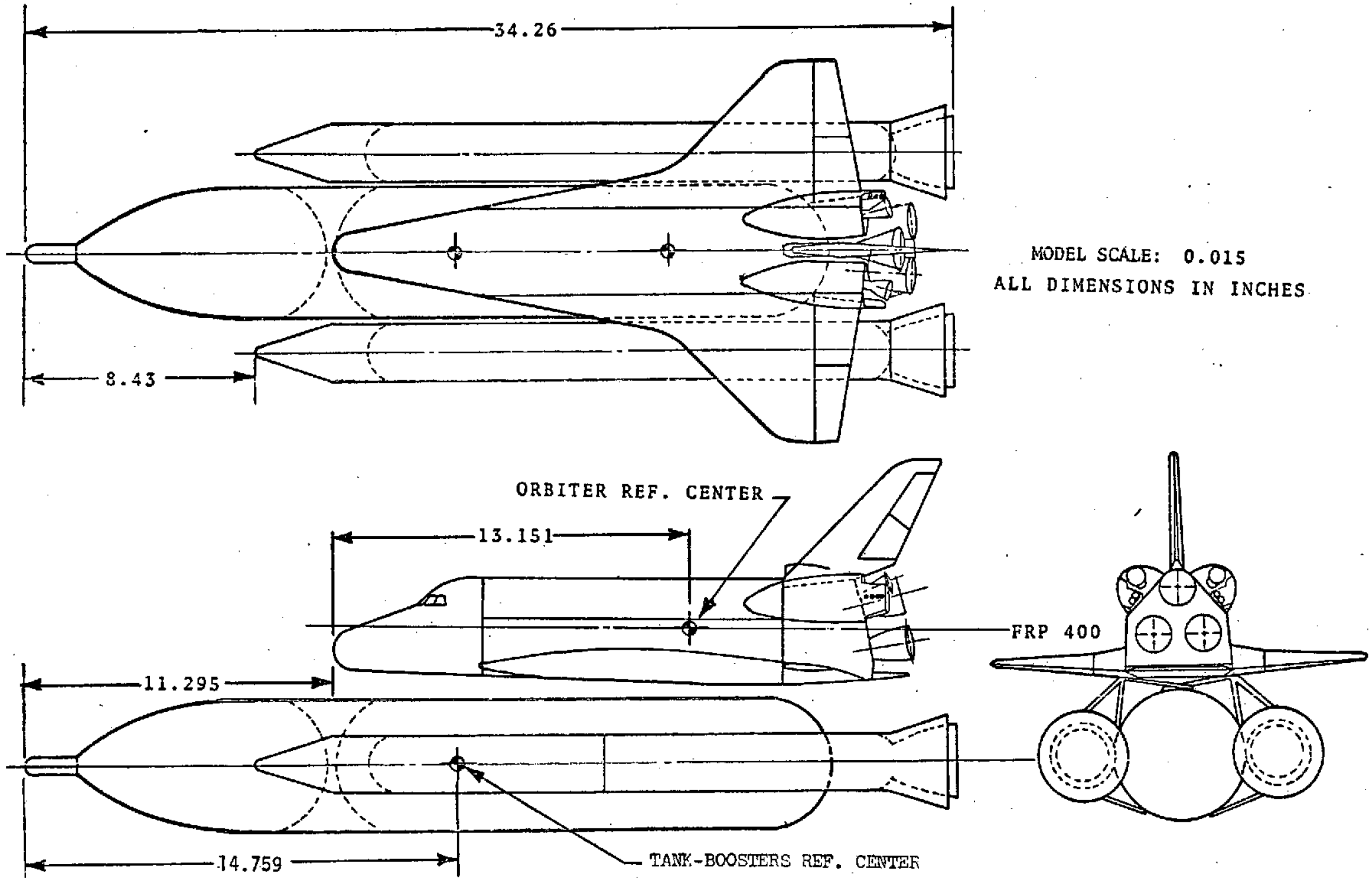
a. General

Figure 1. Axis systems.



b. Tank-Boosters Abort from Orbiter

Figure 1. - Concluded.



(a) IA8 Model 6-OTS Moment Reference Centers

Figure 2. - Model sketches.

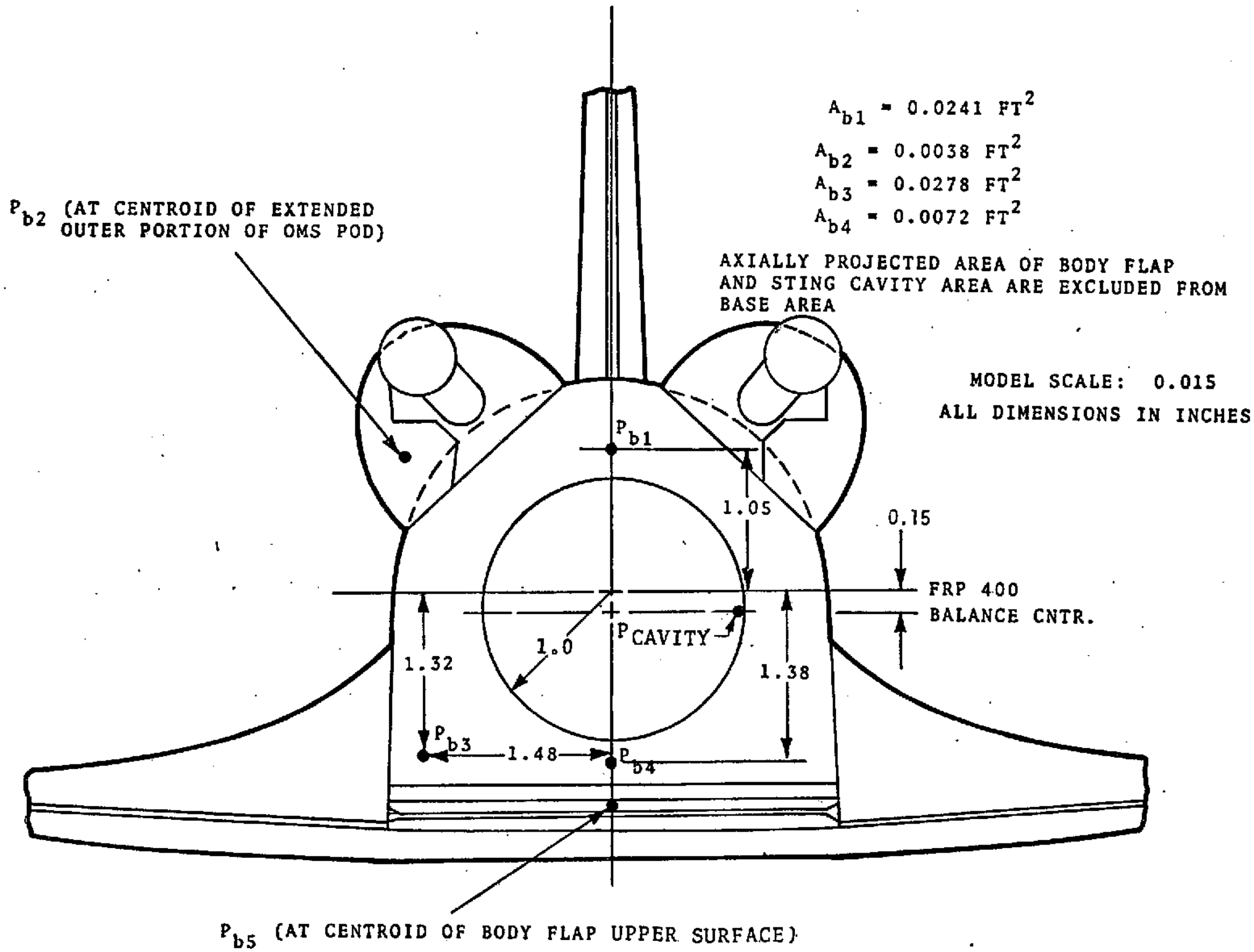
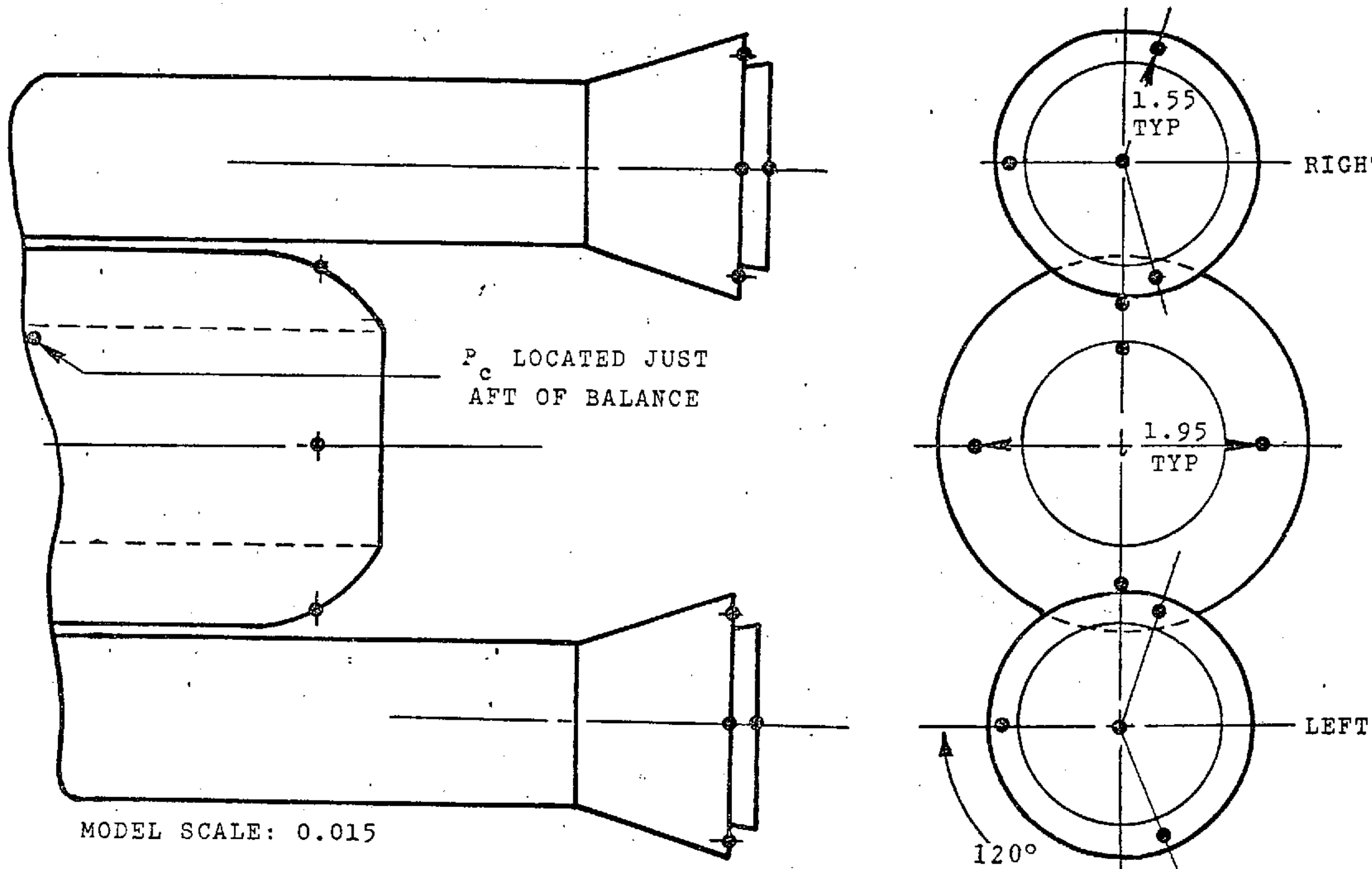


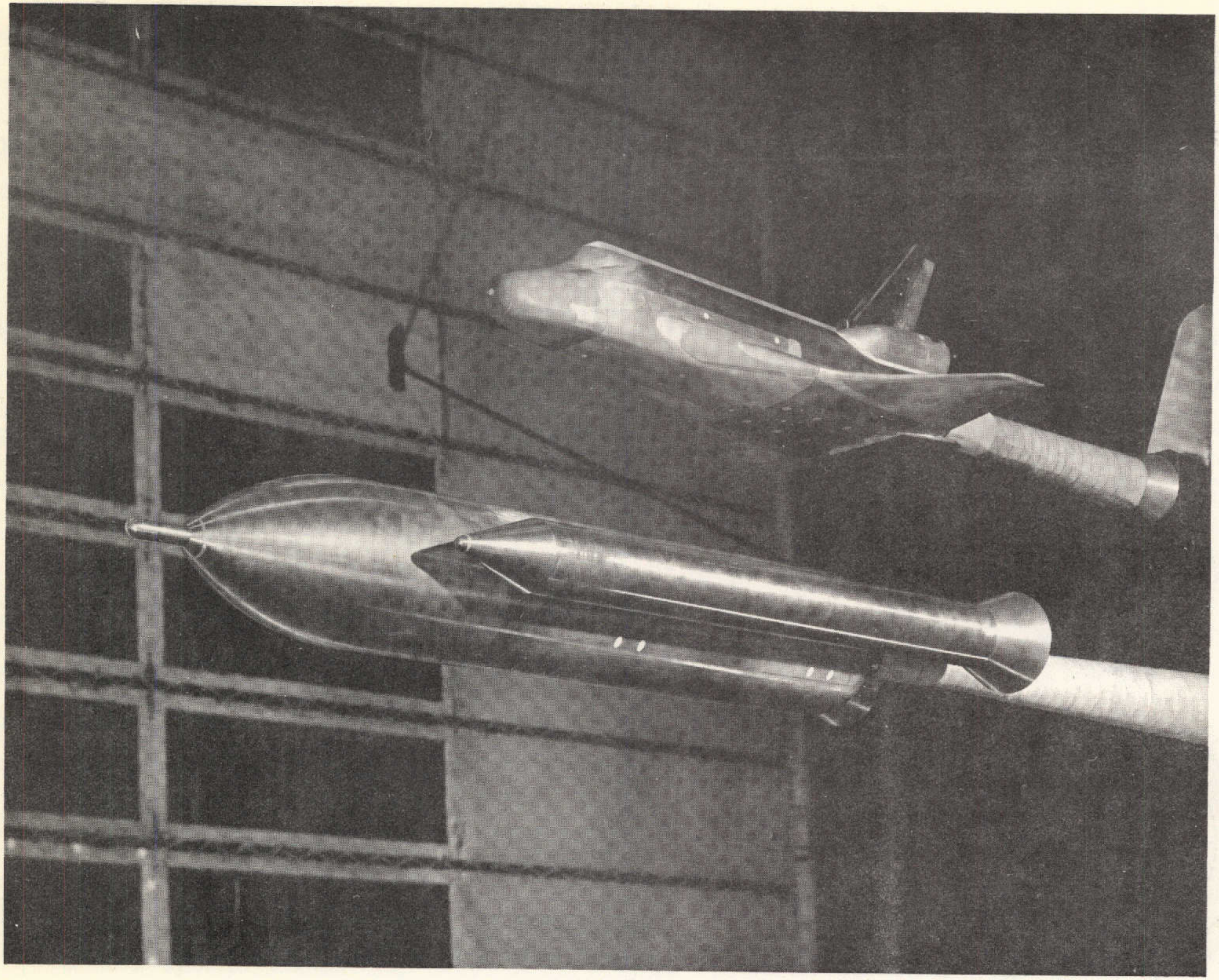
Figure 2.- Continued.
(b) IA8 Model 6 OTS Orbiter Base and Cavity Pressure Locations



NOTE: 1) FOUR PRESSURES ON LEFT BOOSTER WERE MANIFOLDED. THOSE ON RIGHT WERE ALSO MANIFOLDED
2) FOUR BASE PRESSURES ON TANK WERE MANIFOLDED

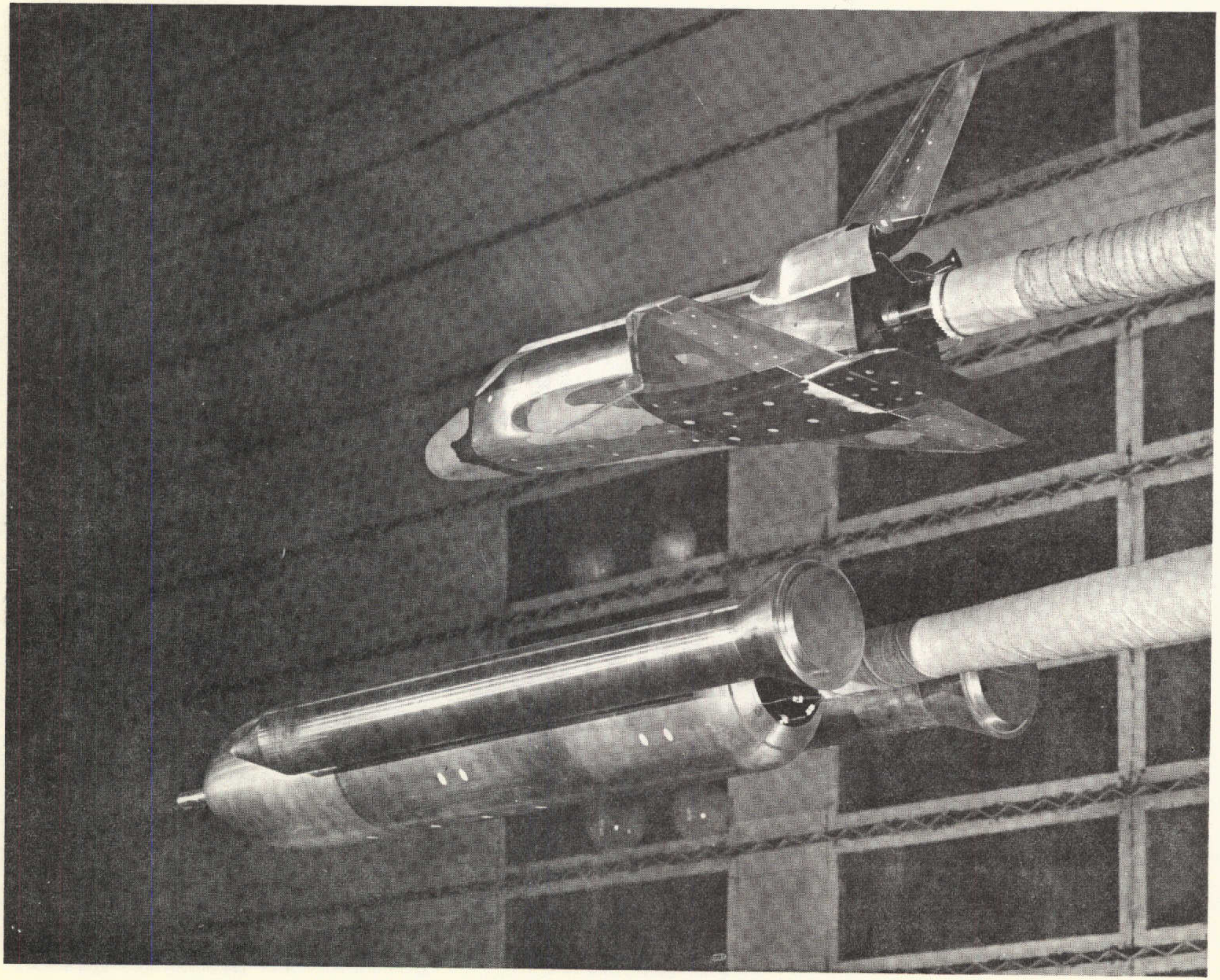
Figure 2.- Concluded.

(c) IA8 Model 6-OTS Booster-Tank Base and Cavity Pressure Locations



a. Front 3/4 view

Figure 3. - Model installation photographs.



b. Rear 3/4 view

Figure 3. - Concluded.